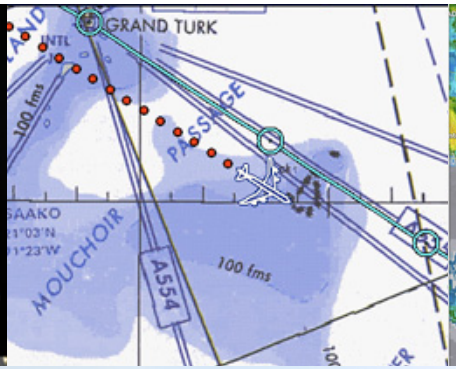
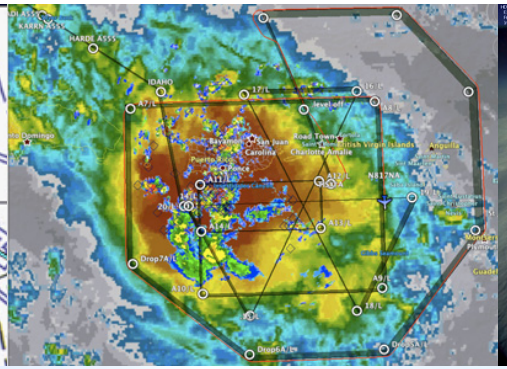
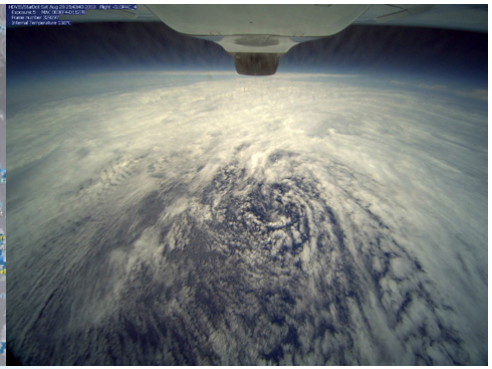



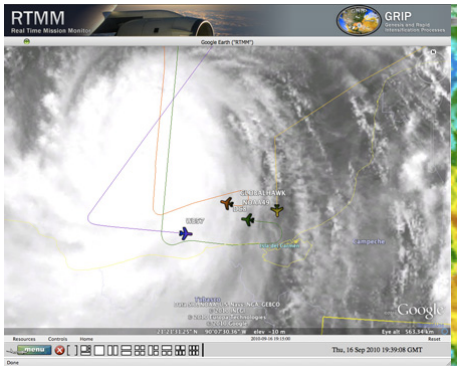



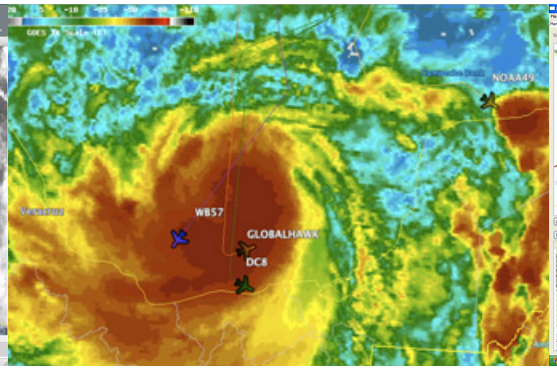
Coordinating Aircraft During NASA Airborne Science Field Campaigns AIST-08-0072

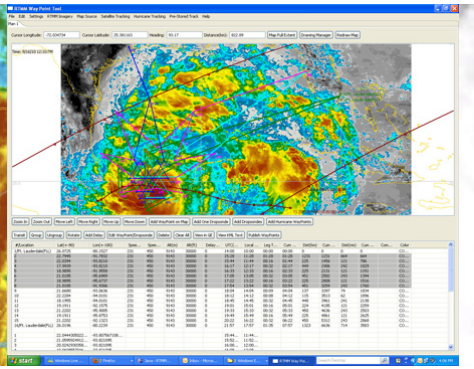
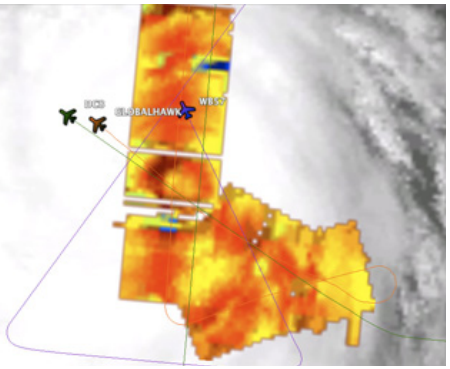
Michael Goodman

Earth Science Technology Forum

21 June 2011





Presentation Outline

- **Introduction**
- What is RTMM?
- Technology Infusion
- Examples and Tools
- Conclusion and Questions

Team Members

Name	Organization	Role
Michael Goodman	NASA MSFC	Principal Investigator
Richard Blakeslee	NASA MSFC	Co-Principal Investigator
Paul Meyer	NASA MSFC	Co-Investigator
Helen Conover	UAHuntsville ITSC	Software Development Team Lead
Michele Garrett	UAHuntsville ITSC	Systems Administrator
John Hall	UAHuntsville ESSC	RTMM System Architect / SW Engineer
Danny Hardin	UAHuntsville ITSC	Co-Investigator / Web Team Lead
Jared Harper	UAHuntsville ITSC	Software and Database Engineer
Matt He	UAHuntsville ITSC	Co-Investigator / SW Engineer
Kathryn Regner	UAHuntsville ITSC	Systems Engineer / Project Management
Tammy Smith	UAHuntsville ITSC	Web Design and Development
Melody Bowling	DFS, Inc.	Budget Analyst

Project Objective

- Develop a science decision-making tool, built upon a service oriented architecture that seamlessly integrates multiple applications for facilitating the monitoring and management of airborne assets in NASA Earth science validation and field campaigns
- Redesign, implement, and operate the Real Time Mission Monitor (RTMM) from a web portal utilizing applications on a common framework for science data visualization and airborne mission management
- Simplify, enhance and expand the user interface and functionality

Presentation Outline

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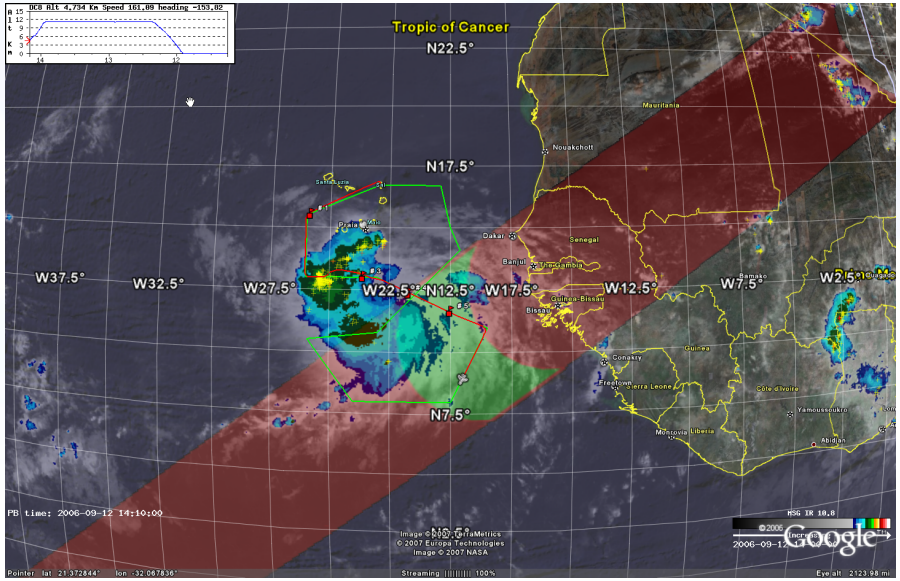
Real Time Mission Monitor
"Making Science Easier"

The Real Time Mission Monitor (RTMM) is an interactive visualization application that provides situational awareness and field asset management to enable adaptive and strategic decision making during airborne field experiments.

- Integrates satellite, airborne, and surface data sets
- Tracks airborne vehicle state information
- Displays model and forecast parameter fields
- Utilizes distributed Web-based architecture



To paraphrase the BASF™ television commercial:
"We don't make the science, we make the science easier"

RTMM Applications
"Making Science Easier"

RTMM supports all phases of field experiments

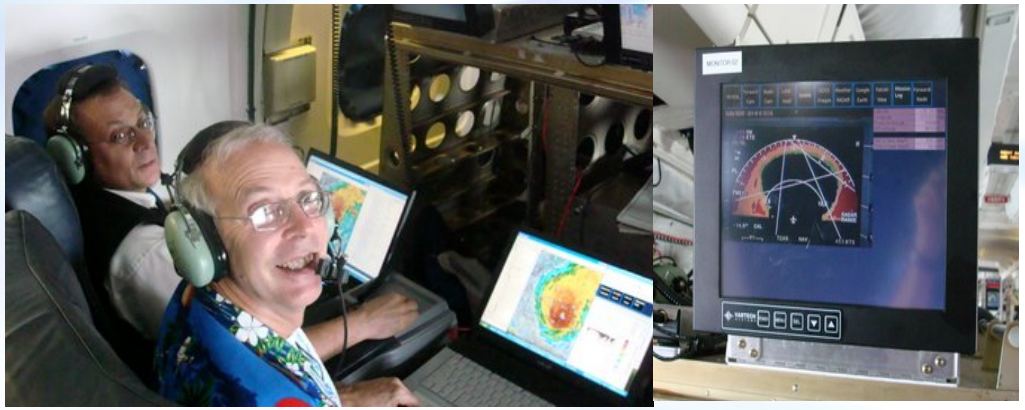
- Pre-flight planning
  - Model and forecast fields
  - Satellite overpass predicts
  - Waypoint Planning Tool
- In-flight monitoring and adaptive flight strategies
  - Operations center focal point
  - Current weather conditions
  - Plane-to-plane data transfer
- Post-flight analyses, research, and assessments
  - Encapsulate and replay missions

Matt He works aboard the NASA DC-8 during a flight over the Gulf of Mexico, Tuesday, Aug. 17, 2010. Photo Credit: (NASA/Paul E. Alers)

Keys to Success
Coordination and Communication

RTMM available for use by user base that includes:

- *Program and Project Managers*
- *PI, Co-I & Research Scientists*
- *Pilots and Flight Engineers*
- *Mission Managers*
- *Educators and Students*
- *Media and Public Affairs*
- *Science Attentive Public*



RTMM (left) and aircraft observation (e.g., radar image of eye shown in right image) provided key "eyes" and guidance.

RTMM enables:

- *Real time interactions and collaborations*
- *Post-flight mission review and case study development*

RTMM used in the cockpit of the DC-8 during GRIP on September 6, 2010.

Presentation Outline

- Introduction
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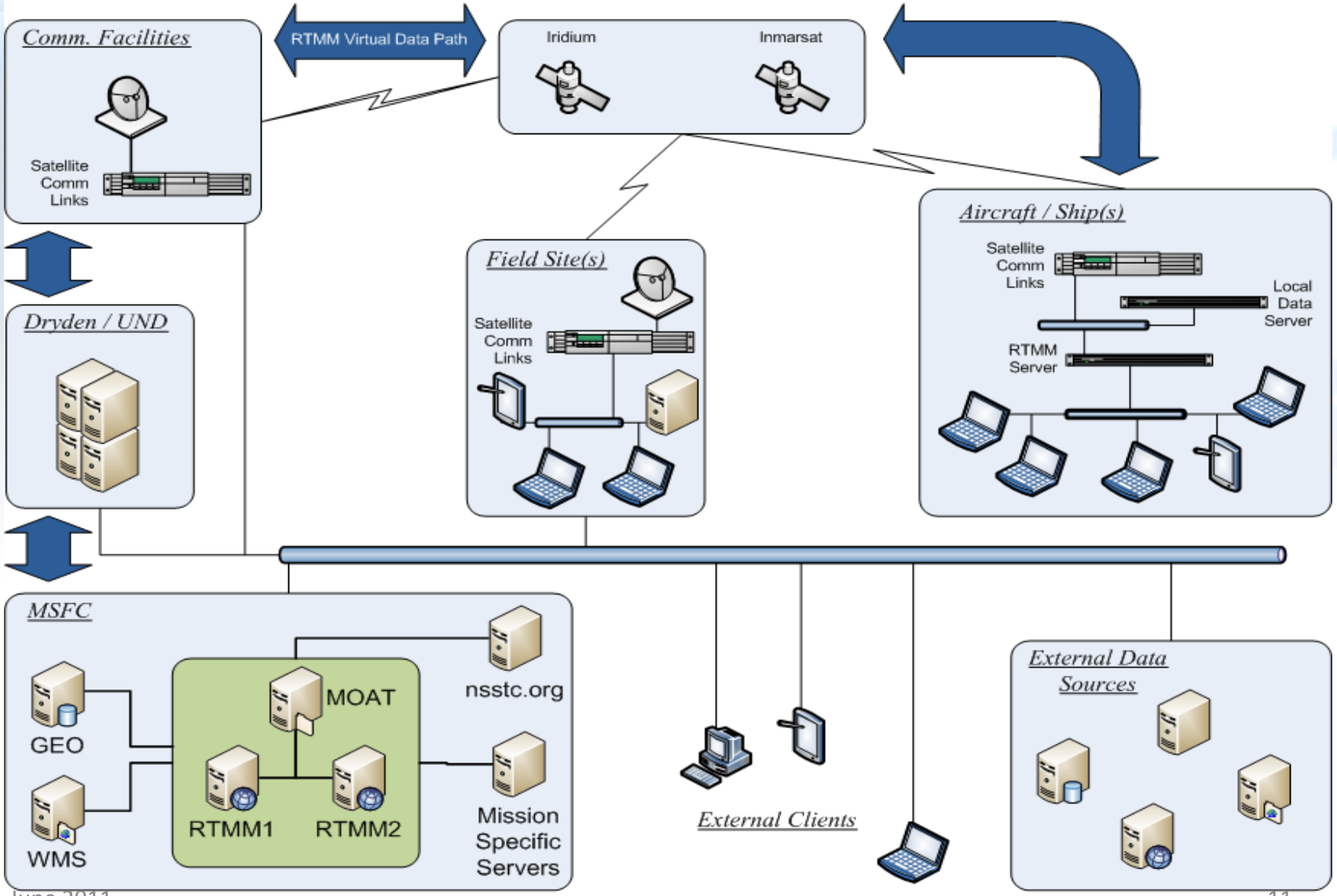
Technology Infusion Approach

"Making RTMM Better"

- Google Earth Plug-in Applications Programming Interface
  - Move RTMM from desktop to web browser application.
  - Investigate and pursue NASA World Wind for use in limited/restricted network bandwidth situations.
- Standard access methods for data, tools and services and to enable sharing of resources
  - e.g., Keyhole Markup Language (KML), Sensor Observation Service (SOS)
- Data Base Management System (DBMS)
  - Maintain information on local and remote data resources, tools and projects in a central, web accessible location.

RTMM System Topology



RTMM Component Status

Future work
In progress
Baseline

External Data Sources

Server Side RTMM

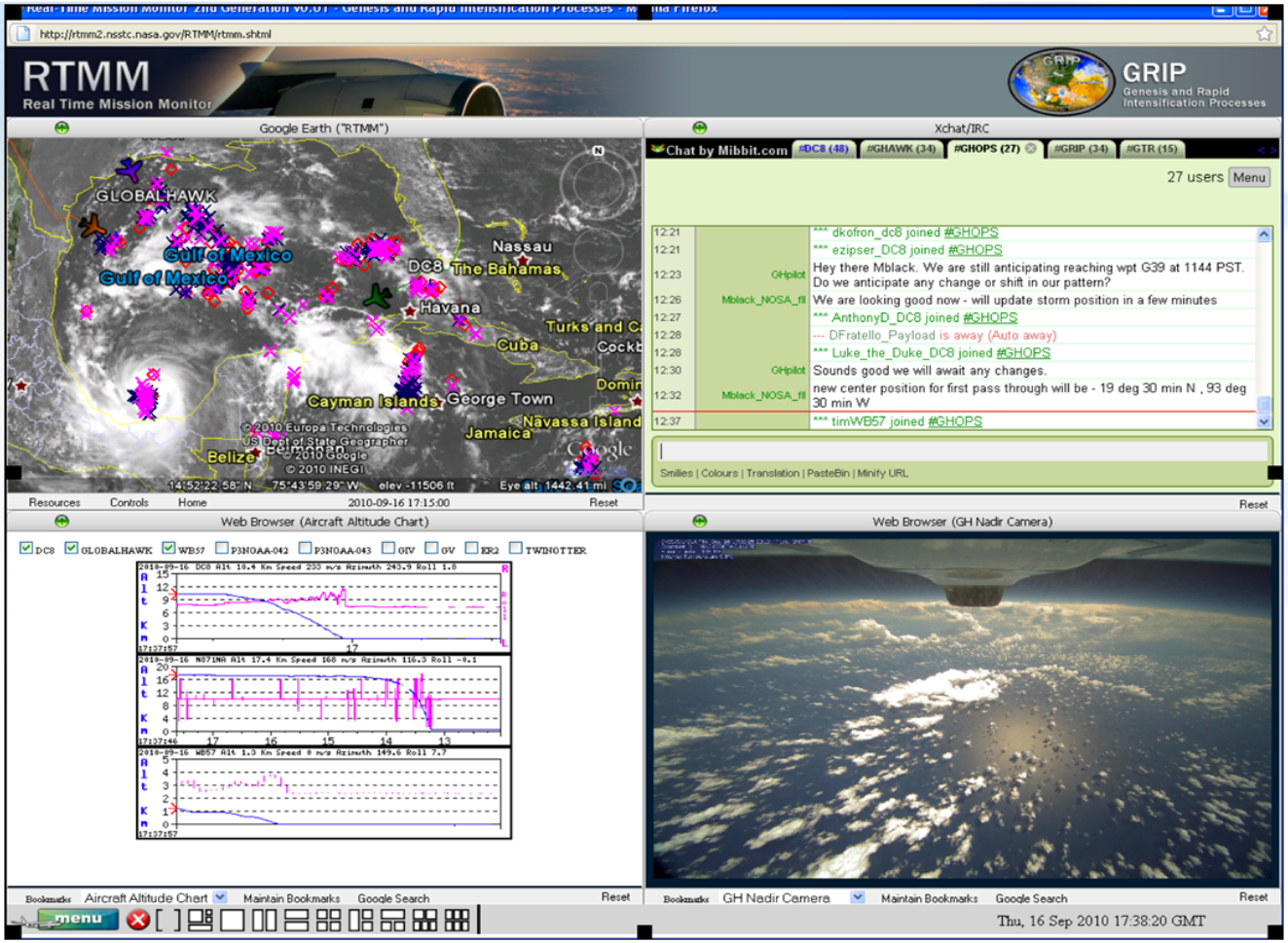
- Ingest, Archive & Processing
- Authentication Services
- Local XChat / IRC Services
- Catalog Services
- Data Services
- Local Data Sources
- Data & Tools Catalog

Client Side RTMM 2nd Generation

- Layout Manager
- Waypoint Planning Tool
- Playback Tool
- XChat / IRC Client
- Data & Tools Registration
- 4D Virtual Globe (GE)
- 4D Virtual Globe (WW)
- Web Viewer
- Graphs

Flexible User Interface

- Multiple windows within the interface to support multi-tasking using different RTMM tools
- Many different layouts possible
- Easy set-up and configuration
- Integrates and displays multiple data types and sources



Screen shot on 16 Sept as Global Hawk, WB-57, and DC8 enter the Gulf for a rendezvous with Hurricane Karl

Presentation Outline

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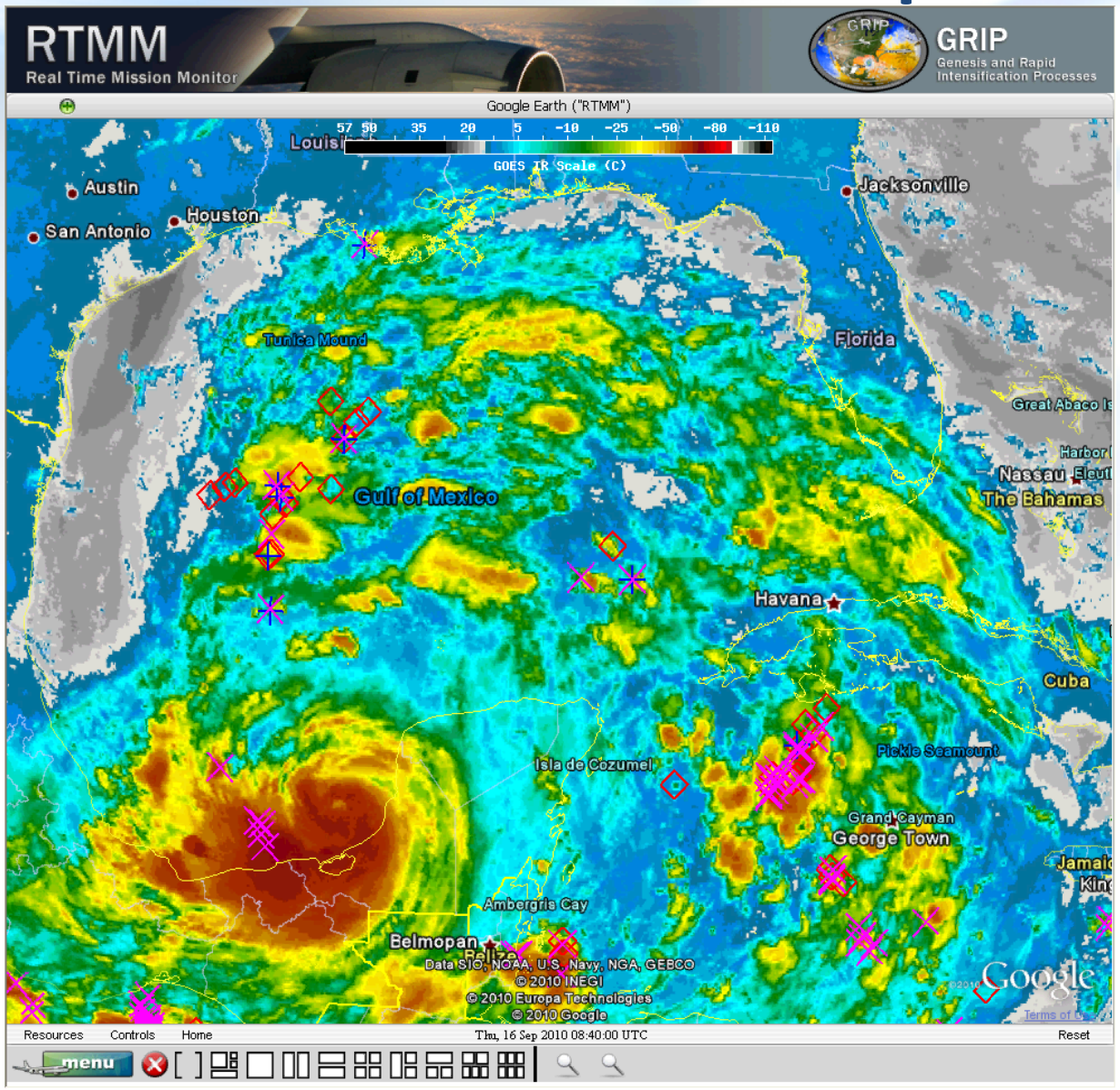
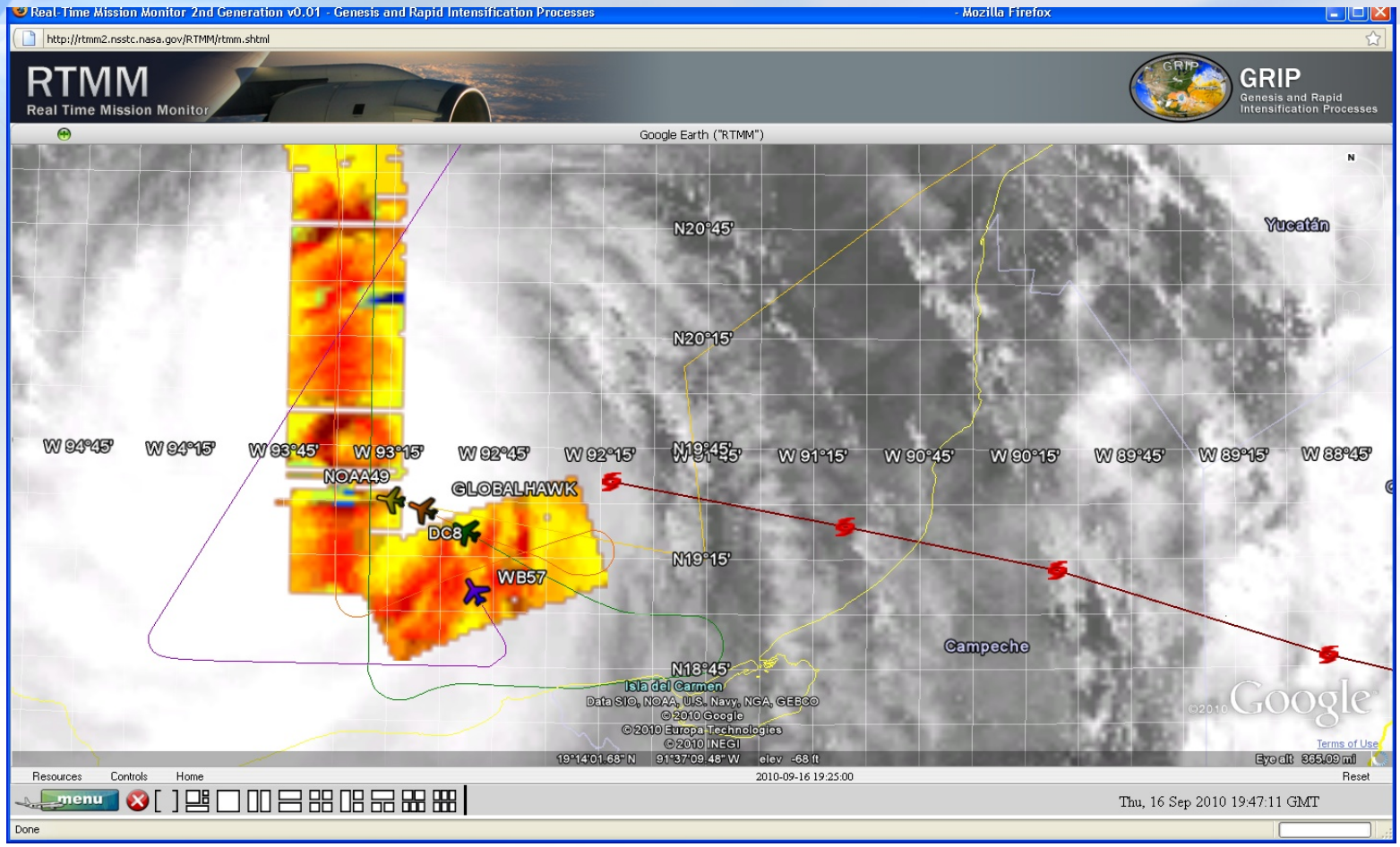
All NASA, NOAA and AF Aircraft
Hurricane Karl – 16 Sep 2010

Start:
16 Sep 2010
0840 UTC



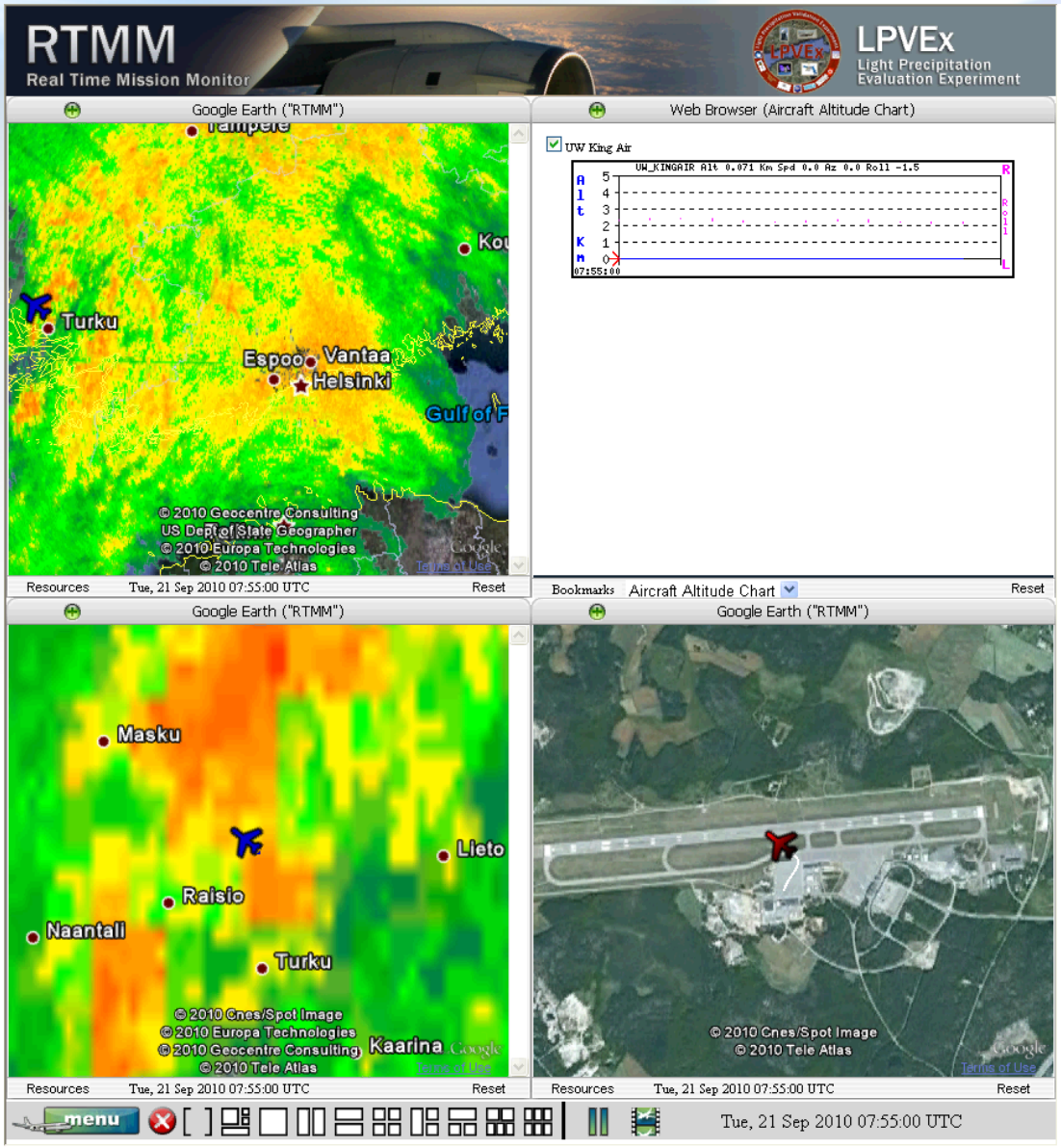
End:
17 Sep 2010
1420 UTC

Real Time Aircraft Data Transfers



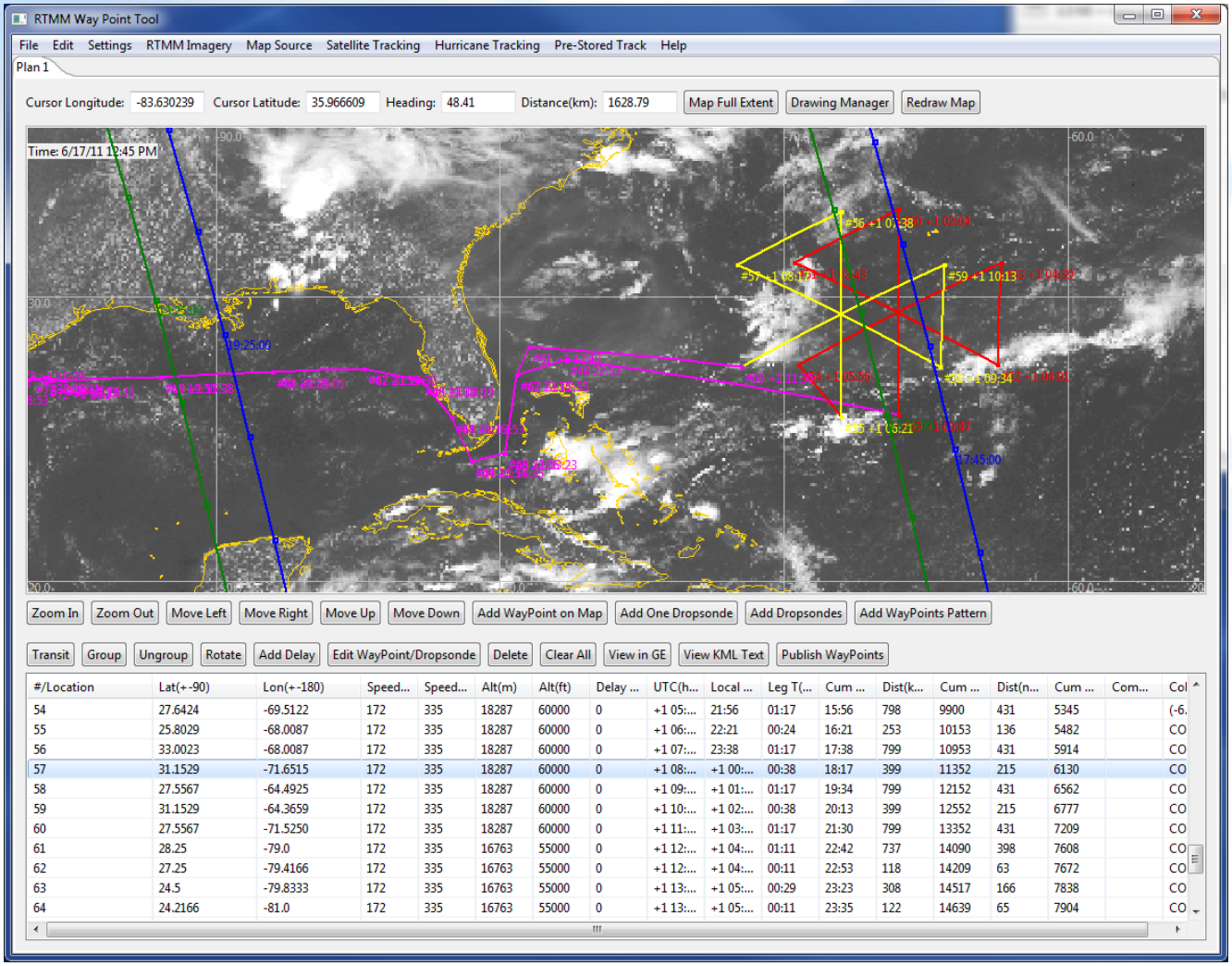
NASA Global Hawk, DC8, and WB57 and the NOAA Gulfstream-IV making a coordinated pass over Hurricane Karl eye. Strip of HAMSR microwave data aboard the Global Hawk captures the developing eye of Karl on 16 Sept 2011.

LPVEx 21 September 2010 Multi-Panel Interface



Waypoint Planning Tool

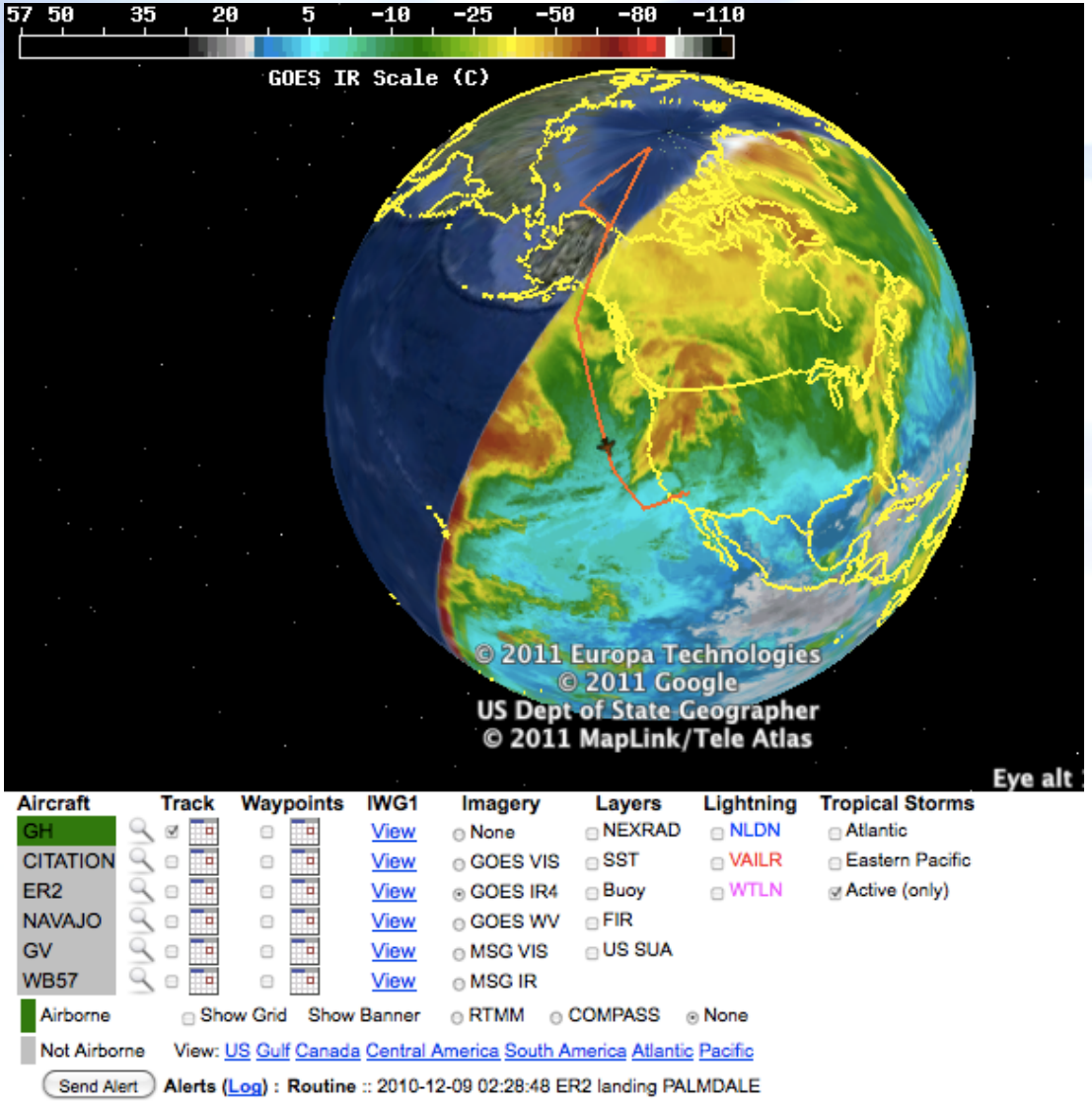
- Many aircraft to choose and easy to add new aircraft
- Predefined flight patterns (e.g., figure-4, butterfly, lawnmower)
- Complicated Global Hawk path uses pre-stored track
- Point and click and rubber-banding allows dynamic track reconfiguration
- Satellite nadir times for Aqua and CloudSat
- List of individual waypoints easily edited



Sample Global Hawk flight to Atlantic Ocean

“RTMM Lite”

Prototype light weight aircraft tracker application provides a simple single-panel user interface for “non-power” users who would like to monitor aircraft flight progress



Recent and Upcoming Experiments

Experiment	*Aircraft*	*Dates*
GRIP **Genesis and Rapid Intensification Processes**	NASA Global Hawk, WB-57 & DC-8 NOAA P3, Gulfstream-IV NSF Gulfstream-V AF C-130	Aug-Sep 2010
LPVEx **Light Precipitation Validation Experiment**	U. Wyoming King Air	Sep-Oct 2010
WISPAR **Winter Storms and Pacific Atmospheric Rivers**	NASA Global Hawk NOAA G-IV	Feb-Mar 2011
MACPEX **Mid-latitude Airborne Cirrus Properties Experiment**	NASA WB-57	Mar-Apr 2011
MC3E **Mid-latitude Continental Convective Clouds Exp**	NASA ER-2 U. ND Citation U. TN Space Institute Piper Navajo	Apr-Jun 2011
SEAC4RS S.E. Asia Composition, Cloud, Climate Coupling Regional Study	NASA ER-2 & DC-8	Aug-Sep 2012
DC3 **Deep Convective Clouds and Chemistry**	NASA DC-8 , NSF Gulfstream-V NCAR C130, *Other aircraft TBD*	Summer 2012
HS3 **Hurricane and Severe Storm Sentinel**	NASA Global Hawks	Summer 2012 - 2014

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Summary

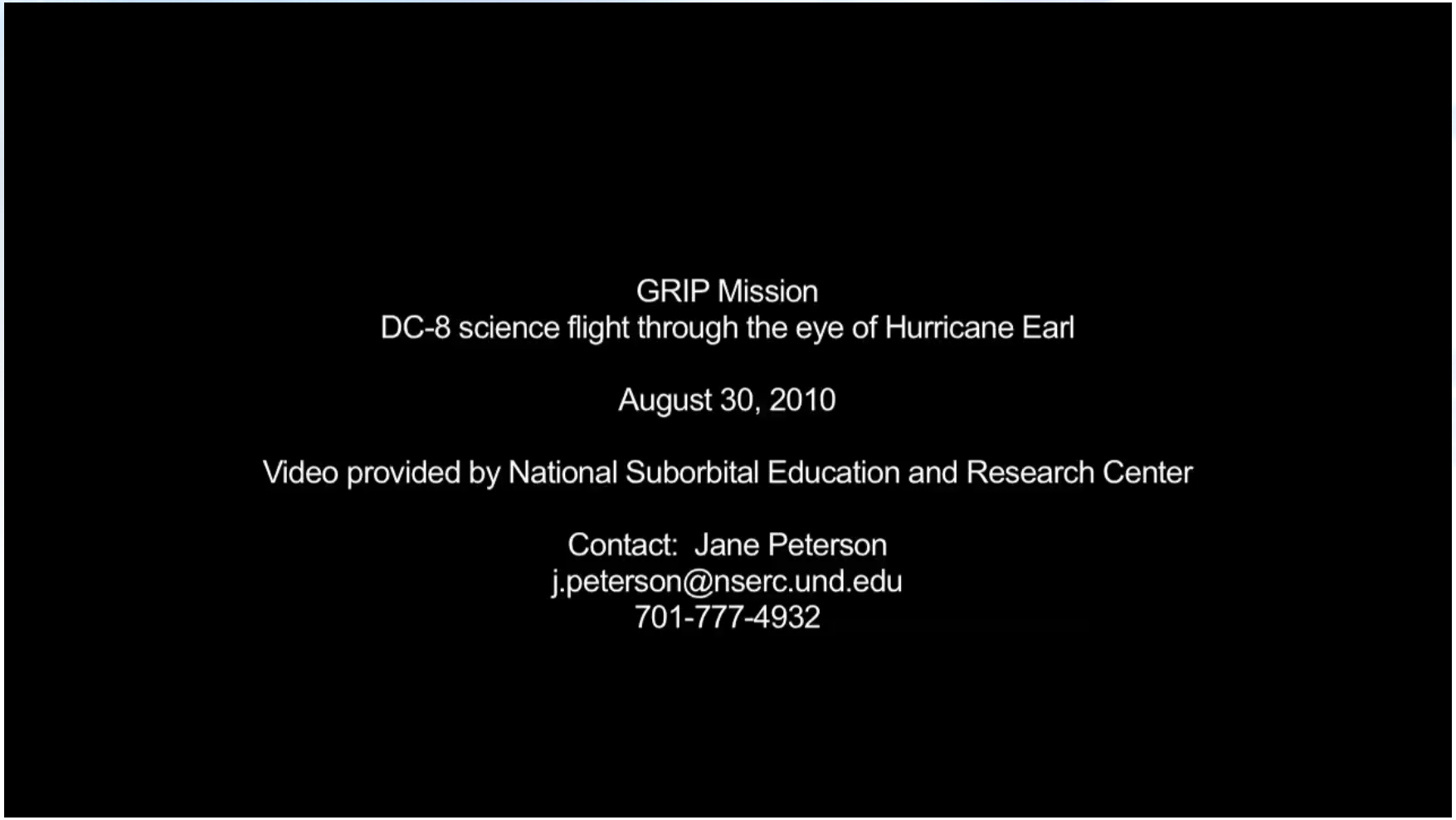
The Real Time Mission Monitor is a well established tool used during NASA airborne field experiments. In the last two years the AIST Technology Infusion for the Real Time Mission Monitor team has enabled

- Redesign of user interface with web portal application
- Completed significant enhancements to the Waypoint Planning Tool
- Power user and "lite" versions
- Poised for use during inter-agency operations

Thank You

Questions?

Bonus Video
Hurricane Earl, 30 August 2010



Backup Charts

Technology/Software Readiness Levels

	TRL	Description
	1	Basic principles observed and reported Transition from scientific research to applied research
	2	Technology concept and/or application formulated Applied research
Initial	3	Analytical and experimental critical function and/or characteristic proof-of concept. Proof of concept validation
	4	Component/subsystem validation in laboratory environment Standalone prototyping implementation and test
	5	System/subsystem/component validation in relevant environment Thorough testing of prototyping in representative environment
Current	6	System/subsystem model or prototyping demonstration in a relevant end-to-end environment (ground or space) Prototyping implementations on full-scale realistic problems
Final	7	System prototyping demonstration in an operational environment (ground or space) System prototyping demonstration in operational environment
	8	Actual system completed and "mission qualified" through test and demonstration in an operational environment (ground or space) End of system development
	9	Actual system "mission proven" through successful mission operations (ground or space) Fully integrated with operational hardware/software systems